TITLE OF THE INVENTION

PUMP SYSTEM FOR DELIVERING PRESSURIZED LIQUID

BACKGROUND OF THE INVENTION

The present invention relates to pump systems for delivering pressurized liquid.

SUMMARY OF THE INVENTION

The pump system of the present invention for providing a pressurized liquid comprises

a. an elevated supply reservoir of a liquid at a first pressure;

b. at least one pair of vertically reciprocating liquid transfer vessels, each of said transfer vessels having

i) a force transfer assembly operatively associated with it that transfers downward force into upward force; and

ii) a liquid pump operatively associated with said force transfer assembly for delivering liquid at a second pressure that is greater than said first pressure; and

c. A storage reservoir below said supply reservoir for receiving liquid from said supply reservoir and delivering said liquid to each of said liquid pumps,

said supply reservoir being adapted to supply said liquid to said transfer vessels under gravity flow, and

said liquid applied to said transfer vessels providing said downward force.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a top plan view of the pump system of the present invention.

Fig. 2 is a side elevation view of the pump system of the present invention, in section taken along the line 1-1 in Fig. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The pump system 1 of the present invention provides a supply of pressurized liquid. It comprises a) an elevated supply reservoir of a liquid at a first pressure; b) at least one pair of vertically reciprocating liquid transfer vessels, each of said transfer vessels having: i) a force transfer assembly operatively associated with it that transfers downward force into upward force and ii) a liquid pump operatively associated with said force transfer assembly for delivering liquid at a second pressure that is greater than said first pressure; and c) a storage reservoir below said supply reservoir for receiving liquid from said supply reservoir and delivering said liquid to each of said liquid pumps, said supply reservoir being adapted to supply said liquid to said transfer vessels under gravity flow, and said liquid applied to said transfer vessels providing said downward force.

The present invention seeks to provide a means for pumping liquid in remote, primitive areas and providing liquid at elevated pressure without the use of a motor or other external propulsion force. It seeks to provide an effective means for providing compressed liquids, such as potable water, in rural, industrial and domestic environs. It also seeks to provide compressed liquids without electrical energy and pumping liquids without expending fuel so as to provide compressed liquids in a self-sufficient manner and without needing any type of fuel. Further, the pump system of the present invention seeks to provide a beneficial source of water for irrigation systems and other similar systems in remote areas. The present invention seeks to provide a means for pumping liquid thereby providing liquid at elevated pressure without the use of a motor or other external propulsion force.

In the pump system 1 of the present invention, and as illustratively shown in Figs. 1 and 2, a sealed main box 2 encloses the component elements of the pump system 1 and seals them from ambient atmospheric pressure. A liquid, such as water, oil, etc., is supplied to the pump system 1 at a first pressure, such as ambient pressure, through inlet 3. The pump system 1, through the agency of its components, then increases the pressure of the liquid to a greater pressure (herein referred to as a pressurized liquid) within the sealed box 2 and delivers the pressurized liquid from an outlet 4 (shown in Fig. 1 as a pair of spaced outlets 4a and 4b.). The main component elements (Fig. 2) of the pump system of the present invention are a supply reservoir 5, a plurality of reciprocating liquid vessels 6a and 6b, a vessel-elevation assembly 7, a plurality of force-transfer assemblies 8a and 8b corresponding to the liquid vessels, a plurality of single-action liquid pumps 9a and 9b corresponding to the force-transfer assemblies, and a lower storage reservoir 10.

During operation of the pump system 1, liquid flows into supply reservoir 5 where it is held for supply and internal distribution in the system. Liquid flows by gravity from the supply reservoir 5 into a first reciprocating liquid vessel 6a and fills that vessel. Upon filling, the vessel 6a descends by gravity and applies a downward force to its associated force-transfer assembly 7a. The force-transfer assembly 7a rotationally converts that downward force into an upward force on the associated single action pump 9a. This upward force acting on the single action pump 9a pumps liquid drawn from the lower storage reservoir 10 out of the pump system 1 through outlet 4a providing compressed liquid. When the vessel 6a has descended to the bottom of its vertical travel, it exhausts its volume of liquid into the lower storage reservoir 5 for use as a supply to single action pumps 9a and 9b. The descent of vessel 6a acts through the vessel-

elevation assembly 7 to raise vessel 6b (which is empty) into position to receive liquid from supply reservoir 5.

The sealed box 2 is a sealed container, preferably of stainless steel, and is preferably configured generally as a rectangular prism with opposed side extensions that house the lower storage reservoir 10 and the exhaust sides of the liquid pumps 9a and 9b. This provides the sealed box 2 with a broad base to resist tipping. In front elevation the box 2 has an inverted "T" configuration. A centrally disposed inlet 3 is provided in the top wall for liquid ingress and a pair of outlets 4a and 4b are disposed in association with reflective liquid pumps 9a and 9b.

The supply reservoir 5 holds liquid for supply to the reciprocating transfer vessels 6a and 6b. It is elevated above the lower storage reservoir 10 and the reciprocating transfer vessels 6a and 6b so that the liquid can flow by gravity from the supply reservoir 5 to the storage reservoir 10 via the transfer vessels 6a and 6b and that liquid can be used as a motive force to drive the pumps 9a and 9b. The liquid flows by gravity from the reservoir 10 into a set of supply manifolds 11a and 11b. Drain ports 12a and 12b from the supply reservoir 5 are each supplied with a filter 13 so that the liquid exiting the supply reservoir 5 is filtered of debris, sediment, etc. Each supply manifold 11a and 11b is provided with a normally closed dispensing valve 14a and 14b that is opened by the corresponding transfer vessel 6a engaging its lower surface. (See Fig. 2, element 14a.)

Each of reciprocating liquid transfer vessels 6a and 6b comprises an enclosed box 15a and 15b, preferably of aluminum, for holding the liquid in its downward travel, a set of guide wheels 16a and 16b, a depending connecting rod 17a and 17b and a set of exhaust valves 18a and 18b. The top wall of each box 15a and 15b is provided with an entry aperture 19a and 19b through which the liquid enters the box 15a and 15b from the corresponding dispensing valve

14a or 14b. The enclosed box 15a or 15b contains the held liquid during its descent. The guide wheels 16a and 16b, preferably of nylon polymer, engage and are guided by the guide walls 20a and 20b in the sealed box 2, the guide walls defining a pair of corresponding guide shafts 21a and 21b, preferably of steel. Each guide shaft 21a or 21b is provided on its interior with a lever 21a and 21b. The bottom wall of the enclosed box 15a or 15b is provided with a centrally disposed connecting rod 17a or 17b for operatively connecting the transfer vessel 6a or 6b to its corresponding force-transfer assembly 8a or 8b. The bottom wall is also provided with a set of peripherally disposed exhaust valves 18a or 18b that are spaced slightly inwardly of the side walls of the box 15a or 15b to clear those side walls. The exhaust valves 18a and 18b (which are normally closed) act as outlets from the transfer vessels 6a and 6b and control the flow of liquid out of the transfer vessels 6a and 6b and into the lower storage reservoir 10. These sets of exhaust valves 18a or 18b are opened by the engagement of their lower surfaces against a set of stops 23a or 23b extending upwardly from the bottom of each of the guide shafts.

The vessel elevation assembly 7 comprises a flexible cable 24, preferably of nylon polymer, (or chain) and a pulley 25. The pulley 25 is mounted with a horizontal axis of rotation between the guide shafts 21a and 21b and their associated transfer vessels 6a and 6b. The flexible cable 24 passes over the pulley 25 and is supported by it. Each of the free ends of the cable 24a and 24b is attached to a corresponding transfer vessel 6a and 6b respectively by an extension 26a and 26b extending outwardly from the boxes 15a and 15b. In this way, the downward movement of one transfer vessel, such as 6a, will pull the other transfer vessel 6b up and vice versa.

Each of the force assemblies 8a and 8b that correspond with their respective reciprocating vessels 6a and 6b comprise a slotted sliding link bar 27a and 27b, a slotted pivot bar 28a and 28b

and a pivot shaft 29a and 29b. The pivot shaft 29a or 29b is mounted for the axis of rotation of the pivot bar 28a and 28b to be horizontal and parallel to the axis of rotation of the pulley 25. Pivot bar 28a and 28b, preferably of bronze, is each mounted with its plane of rotation parallel to that of the pulley 25. The pivot bar 28a and 28b is provided with a transverse slot 30a or 30b through which the sliding bar 27a or 27b slides and is retained so that the sliding bar 27a or 27b slides in a plane that is parallel to the plane of rotation of the pivot bar 28a or 28b. The transverse slot 30a or 30b is radially offset from the axis of rotation of the pivot bar 28a or 28b. The transverse slot 30a or 30b is rectangular in cross-section. Each sliding bar 27a and 27b, preferably of extruded steel, is provided with a proximal rectangular slot 31a or 31b and a distal rectangular slot 32a or 32b, as the case may be. The connecting rod 17a and 17b of each transfer vessel is provided with a slot 33a or 33b at its end that is closed by a cross-shaft 34a or 34b. The cross-shaft 34a and 34b passes through the proximal slot 30a and 30b and allows the downward force of the transfer vessel 6a or 6b to be transferred to the force-transfer assembly 8a or 8b, respectively. Each cross-shaft 34a or 34b slides in proximal slot 31a or 31b and the sliding link bar 27a or 27b pivots or rotates with respect to the connecting rod 17a or 17b during the reciprocating movement of the transfer vessels 6a and 6b. Similarly, the connecting rod of the piston of each pump 9a and 9b is provided with a transverse rectangular slot at its upper end that is closed by a cross shaft that passes through the distal slot 32a and 32b and allows the downward force of the sliding link bar to be transferred to the piston of the pump through the pump connecting rod.

Each of the single-action liquid pumps 9a and 9b is a vertical stroke pump, meaning that it delivers liquid during its upward vertical stroke, and comprises a piston connecting rod 35a and 35b, a piston 36a and 36b, a pump cylinder 37a and 37b, an exhaust manifold 38a and 38b, a

one-way, poppet regulator valve 39a and 39b and an exhaust pipe 40a and 40b. The upper end of each piston connecting rod is provided with a transverse slot 41a and 41b that is closed by a cross shaft 42a and 42b. The distal slot 32a and 32b of each link bar 27a and 27b slides and rotates on this cross shaft in transferring force from the force-transfer assembly 8a and 8b to the pump 9a and 9b. The connecting rod 35a and 35b is centrally disposed with respect to and fixed to the piston 36a and 36b. Piston 36a and 36b is disposed in, and rides in, cylinder 37a and 37b. Liquid enters the cylinder 37a or 37b through valve means (not shown) and is forced out of the cylinder 37a or 37b by the upward movement of the piston 36a or 36b and through exhaust manifold 38a or 38b, respectively. The poppet regulator valve 39a or 39b controls flow out of the exhaust manifold 38a or 38b, respectively, and prevents return flow of liquid into the cylinder 37a or 37b through the manifold 38a or 38b during the downstroke of the piston 36a and 36b. The liquid exits the pump 9a and 9b as a compressed liquid at a pressure elevated above the pressure of the supply reservoir by the force multiplier action of the force transfer assembly 7a and 7b. This force multiplier action results from the distance between the axis of cross shaft 34a (or 34b) and that of pivot shaft 29a (or 29b) being greater than the distance between the axis of cross shaft 42a (or 42b) and that of pivot shaft 29a (or 29b.)

The lower storage reservoir 10 comprises the bottom wall and the lower portions of the front, back and outer side walls of the sealed box 2. It acts as a sump for holding the liquid exhausted from transfer vessels 6a and 6b as the gravity feed of the liquid from the supply reservoir 5 to the storage reservoir 10 is recovered as motive force for the pumps 9a and 9b to provide compressed liquid.

In operation, liquid flows under gravity into the supply reservoir 5 and fills the supply manifolds 11a and 11b through drain ports 12a and 12b. Preferably, this outlet liquid is filtered

of debris and particulates by filters 13 so that such debris and/or particulates does not clog or otherwise impair the functioning of downstream vessels, piping and valving.

From the supply reservoir 5, a volume of filtered liquid passes through the supply manifold 11a and out the dispensing valve 14a into a reciprocating transfer vessel. The filtered liquid fills the transfer vessel 6a until the weight of the volume of liquid in the transfer vessel 6a overcomes the resistance of the force transfer assembly 8a and the associated pump 9a.

At that point, the liquid-filled transfer vessel 6a descends down the guide shaft 21a until it reaches the bottom of the shaft. Stops 23a at the bottom of the guide shaft 21a engage receptacle exhaust valves 18a and the weight of the receptacle 6a and the liquid in it opens them, the liquid flows out of the transfer vessel 6a and into the storage reservoir 10.

Meanwhile, during the descent of the transfer vessel 6a, the force of the weight of the liquid and the transfer vessel 6a and the downward movement of the transfer vessel 6a have pushed the force transfer link bar 27a down and driven the other end of the bar 27a up. This lifts the piston rod 35a of the pump 9a up and its connected piston 36a up.

The upward movement of the piston 36a forces liquid, under elevated pressure, through one-way, poppet regulator valve 39a up the exhaust pipe 40a and out the outlet 4a.

When one reciprocating vessel, such as transfer vessel 6a, is full of liquid, the other transfer vessel 6b is empty. The filled transfer vessel 6a releases itself from dispensing valve 14a of the supply manifold 11a of supply reservoir 5 and it drops while the empty reciprocating vessel 6b that is down rises and returns to its upper position to fill with liquid from supply reservoir 5. This alternating reciprocating movement of the reciprocating vessels 6a and 6b provides an alternating lineal movement and alternating downward force that is translated, by respective force-transfer assemblies 8a and 8b, to reciprocating lineal force for driving the

respective pumps 9a and 9b. The force-transfer assemblies 8a and 8b multiply the downward force of respective reciprocating vessels 6a and 6b in driving their associated vertical stroke, single action pumps 9a and 9b.

While the pump system of the present invention has been described with respect to a single unit or sealed box and a single pair of liquid transfer vessels, force transfer assemblies, and liquid pumps, the pump system may also take the form of multiple units in parallel or in series or in the form of multiple pairs of liquid transfer vessels, force transfer assemblies, and liquid pumps.

The features of the invention illustrated and described herein is the preferred embodiment. Therefore, it is understood that the appended claims are intended to cover the variations disclosed and unforeseeable embodiments with insubstantial differences that are within the spirit of the claims.